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(54) **Evaporator with solvent recovery feature.**

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(73) Proprietor: ZYMARK CORPORATION
Zymark Center,
68 Elm Street
Hopkinton
Masschusetts 01748 (US)

(72) Inventor: Roe, John S.
111 Acorn Street
Millis,
Massachusetts (US)
Inventor: Simonson, Larry A.
55 Pine Hill Road
Ashland,
Massachusetts (US)

(74) Representative: Warren, Anthony Robert et al
BARON & WARREN,
18 South End,
Kensington
London W8 5BU (GB)

EP 0 501 665 B1

Description

Evaporation is a common technique used in modern analytical chemistry laboratories. It is frequently used to concentrate the end product of extraction operations for further analysis by techniques such as gas or liquid chromatography.

In environmental analysis, the volume of extract solvent that needs to be concentrated is usually large, 200-500ml. An evaporation method called Kuderna-Danish is used widely in this respect. However, this procedure has drawbacks: it is slow, recoveries of dissolved analytes in the concentrated fraction are poor, the glassware used is expensive and fragile, and the process is difficult to automate.

An improved technique for evaporating solvent for analyte concentration is found in Friswell, US-A-4,707,452. Using this method a stream of gas is directed in a helical path down the inside wall of an open evaporation vessel seated in a temperature controlled bath. This method provides a more efficient solvent evaporation, thus allowing for the use of lower bath temperatures to prevent the degradation of temperature-labile analytes dissolved in the solvent inside the evaporation vessel. However, the Friswell system does exhibit certain disadvantages. First, a large amount of gas is required to accomplish evaporation. Inert gases such as argon or nitrogen are commonly used for this purpose, and although readily available, they are expensive in the preferred highly pure form. Second, the vapors from the solvents evaporated, typically organic solvents like chloroform and hexane, are toxic. Good laboratory practice mandates that evaporated solvent vapors be removed by standard laboratory ventilation hood systems. Current United States federal and state environmental regulations govern the release of small amounts of these vapors in this way, but larger amounts can cause problems for laboratories. Third, the purified solvents evaporated are costly, and recovery of the evaporated solvent for recycling would be desirable.

The object of this invention, therefore, is to provide an improved evaporation apparatus which provides for solvent recovery.

The invention consists in an evaporation apparatus including a vessel defining an opening at the top thereof and forming an evaporation chamber to hold a liquid composition; a condenser assembly disposed above and hermetically sealed to the vessel and having a wall defining a condensation chamber communicating with the evaporation chamber through the opening, an accumulator for receiving liquid condensed on the wall, and a drain for removing liquid received by the accumulator; a fluid drive disposed above the condenser assembly and adapted to produce fluid flow downwardly through the condensation chamber and into contact with the liquid composition in the evaporation chamber and then upwardly into the condensation chamber; a heating mechanism for heating the liquid composition in the evaporation chamber so as to cause evaporation thereof; and a cooling means for cooling the wall so as to produce condensation thereon of vapor included in the fluid flowing upwardly from the evaporation chamber. Operational efficiency is improved by the accumulator which recovers solvent for reuse.

According to one feature of the invention, the wall includes a substantially vertical condensation tube, the accumulator is an annular trough terminating a bottom of the tube, and the drain is a port in a bottom of the trough. Solvent is conveniently recovered by the annular trough at the base of the tubular condensation wall.

According to other features of the invention, the cooling means comprises an annular shroud surrounding the condensation tube and defining a fluid inlet port and a fluid outlet port, and the tube, the annular trough and the annular shroud are an integrally formed unit. These features simplify use of the apparatus and reduce its fabrication costs.

According to other features of the invention, the fluid drive comprises a fan, and an assembly defining an air tightly sealed fan chamber retaining the fan and communicating with the condensation chamber, and the fan is adapted to produce air flow in directions radial with respect to the tube. The tubular condensation chamber and radially directed air flow result in a helical path of air flow that creates a vortex in the gas above the liquid composition and thereby enhances the evaporation process.

According to yet another feature of the invention, the fan assembly comprises a dome shaped enclosure enclosing the fan and having an open bottom end sealed to an upper end of the tube. The domed enclosure assists in the creation of the desired vortex.

According to a further feature, the invention includes a closed supply housing sealed between the condenser and the vessel, and defining a feed port for injecting a solvent into the vessel. Provision of the feed port allows for the injection of additional solvent during the evaporation process.

According to a further feature of the invention, the tube, the annular trough and the supply housing are an integrally formed unit. These features simplify comprehensive use of the apparatus and reduce its fabrication costs.

According to an additional feature of the invention, the fluid drive is adapted to produce turbulent flow of gas and vapor but substantially no splattering at the surface of the liquid. These features provide an enhanced rate of evaporation.

In a featured embodiment of the invention, the heating mechanism comprises a base defining a liquid reservoir, a heater for heating a liquid volume retained in the reservoir, and a vessel retainer for retaining the vessel in a position at least partially submerged in the liquid volume. The heated liquid volume enhances the evaporation process.

According to specific features of the above embodiment, the condenser is separable from the vessel and the fluid drive; and the base further defines a condenser retainer adapted to retain the condenser after separation from the vessel and a fluid drive retainer adapted to retain the fluid drive after separation from the condenser means. These features facilitate handling of the system's components during periods between evaporation cycles.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

Fig. 1 is a perspective view of an evaporation system 11 embodying the invention;

Fig. 2 is a cross-sectional view of an evaporator assembly included in the evaporation system of Fig. 1; and

Fig. 3 is an exploded perspective view of a fluid drive assembly included in the evaporation system of Fig. 1.

An evaporation system 11 is illustrated in Fig. 1 which includes a console base unit 12, and a strip heater element 13 and an evaporation sensor 14 retained thereby. Also included and retained by an upper surface 15 of the base unit 12 are a pair of supply fixtures 16 and a pair of return fixtures 17 communicating with fluid couplings 20 adapted for connection to a conventional source (not shown) of cooling fluid, such as a water tap and drain. An additional constituent of the evaporation system 11 is an evaporator assembly 21 consisting of an evaporation assembly 22, a fluid drive assembly 23 and a condenser assembly 24 straddled therebetween.

The base console 12 defines a reservoir 25 for retaining a liquid volume heated by the heater element 13. Formed in the upper surface 15 are spaced apart retainer openings 26, each for accommodating one of the evaporation vessels 22. A rack 27 having an upper shelf 28 and a lower shelf 29 is retained within the reservoir 25. Defined by the upper shelf 28 are a pair of retainer openings 31 axially aligned with the retainer openings 26 and the lower shelf 29 similarly defines a pair of also aligned smaller retainer openings 32. A pair of spaced apart cylindrical retainer recesses 33 extend upwardly from the upper surface 15 of the base console 12. Also extending upwardly from the upper surface 15 is an upright 35 having an upper end that retains a horizontally oriented support plate 36. Formed in the support plate 36 are a pair of mounting recesses 37, each of which is intersected by a mounting slot 38. The base console 12 further accommodates a control panel 41 mounted on the surface 15.

As shown in Fig. 2, the evaporation assembly 22 includes a lower cylindrical vessel 40 and an upper solvent supply housing 43 defining a feed port 39, supported thereby. Forming the evaporation vessel 40, is a downwardly, inwardly tapering, hollow central portion 44 straddled by a hollow, cylindrical upper portion 45 and a hollow, tip portion 46. The outer surface of the upper cylindrical portion 45 is dimensioned to be slidably received by the aligned retainer openings 26, 31 in, respectively, the upper surface 15 and the upper shelf 28 while the tip portion 46 is dimensioned to be slidably received by the smaller retainer openings 32 in the lower shelf 29 (Fig. 1). Also receiving the tip portion 46 is a receiving cavity 48 in the evaporation sensor 14. Terminating the upper end of the upper cylindrical portion 45 is a collar portion 51 that defines a circular evaporator mouth 52. A lower nose portion 53 of the supply enclosure 43 is received by and closely fitted to the collar portion 51 so as to form therewith a hermetic seal. Together, the vessel 40 and the solvent supply enclosure 43 form an evaporation chamber 55.

The condenser assembly 24 includes a lower trough portion 62 and a hollow cylindrical, upper body portion 63. An outer periphery of the trough portion 62 is joined to the body portion 63 and an inner periphery thereof is joined to the supply enclosure 43 of the evaporation assembly 22. Communicating with the trough portion 62 is an externally threaded drain port 65. The cylindrical body portion 63 forms a condenser chamber 66 surrounded by an annular shroud 68 that, defines therewith a cooling chamber 69. An externally threaded inlet port 71 and an externally threaded outlet port 72, respectively, are disposed at opposite ends of the cooling chamber 69. Terminating an upper end of the body portion 63 is a condenser collar portion 74 that defines a condenser mouth 75. Preferably, the cylindrical body portion 63, the annular trough portion 62, the supply housing 43 and the annular shroud 68 comprise an integral unit made of glass or other suitable material not susceptible to attack by organic solvents.

As shown most clearly in Fig. 3, the fluid drive assembly 23 includes a hollow dome enclosure 70 that defines a fan chamber 73. Terminating a lower open end of the dome 70 is a condenser nose portion 77 that is received by and closely fitted to the condenser collar portion 74 so as to provide a hermetic seal therewith. An externally threaded neck 78 terminates an upper portion of the hollow dome 70 and defines an entry opening 79. The hollow dome 70 and the vessel 40 also are prefer-

ably made of glass or other suitable material not susceptible to attack by organic solvents.

Additional constituents of the fluid drive assembly 23 are a fan 80, a cylindrical motor case 81, a motor 82 retained thereby, a coupling element 83, and a seal member 84. Rotatably keyed to the motor 82 is a drive shaft 85 that defines a cylindrical recess 86 enclosing a plurality of O-rings 87. The coupling element 83 includes a centrally apertured cover portion 91; a hollow cylindrical middle portion 92 and an internally threaded hollow shank portion 93. Securing the cover portion 91 to the motor 82 are a plurality of screws 95. The seal member 84 has a hollow cylindrical stopper portion 96 defining an entry orifice 97 and an outwardly extended flange portion 98. Forming the fan 80 is a rectangular paddle portion 101 and a stem portion 102 projecting therefrom.

After assembly of the fluid drive assembly 23, the cover portion 91 of the coupling element 83 is press fitted with the motor 82 into an open lower end 103 of the motor case 81. The drive shaft 85 is received by a hollow cavity 105 (Fig. 2) in the middle portion 92 of the coupling element 83. After positioning of the cylindrical stopper portion 96 into the entry opening 79 of the hollow dome 70, the externally threaded neck 78 thereof is threadedly engaged with the shank portion 93 of the coupling element 83 moving the flange portion 98 of the seal member 84 into engagement with a stop surface 107 (Fig. 3) formed at the bottom of the middle portion 92. The fan 80 then is assembled by inserting the stem portion 102 through the entry orifice 97 in the seal member 84 and the cavity 105 in the middle portion 92 of the coupling element 83 and into the cylindrical recess 86 for removable retention by the O-rings 87.

OPERATION

After complete assembly, an evaporator assembly 21 is placed in one set or, if desired in both sets of the retainer openings 26, 31, 32 as shown in Fig. 1. Next, threaded couplings 108 (Fig. 2) are used to connect an outlet tubing 111 between the outlet port 72 and the return fixture 17 and an inlet tubing 112 between the inlet port 71 and the supply fixture 16. In addition, a drain tubing 113 is connected by a threaded coupling 108 between the drain port 65 and a suitable collection vessel (not shown). A desirable rotational speed for the fan 80 is chosen by use of a selector 121 disposed on the panel 41 and connected to a control system (not shown) which regulates fan speed. Increasing fan speed increases the rate of evaporation. However, fan speed is limited to prevent excessive turbulence that would agitate the liquid sufficiently to splatter droplets of solvent (containing dissolved solute) in the evaporation vessel 40. Such droplets could be launched from the liquid body and impinge on the condenser wall 63 resulting in a reduced recovery of dissolved solute. In addition, a temperature for the liquid bath in the reservoir 25 is chosen by use of another selector 122 on the panel 41. The selector 122 also is connected to a control system (not shown) which maintains a desired temperature for the liquid bath in the reservoir 25.

Once fan speed and bath temperature are selected, evaporation begins. The fan 80 directs air radially against the dome 70 creating along the wall of the evaporation chamber 55 a downwardly helical flow path that agitates or swirls a sample gently, creating a vortex action in the vessel 40. This vortex action, in combination with the applied heat increases the evaporation rate significantly with respect to prior systems. The fan action also serves to establish an equilibrium of vaporized solvent throughout the evaporation chamber 55. Solvent vapor naturally travelling upwardly from the center of the vortex is assisted by the action of the fan 80. When the vapor reaches the spinning fan 80, its action directs the vapor to the cool inner wall of the condenser 63. There, the vapor condenses and the condensed solvent travels down the inner wall of the body 63 until it reaches the trough 62. Collected liquid flows out of the trough 62 through the drain port 65 and the tubing 113 to a receptacle (not shown) for collecting the recovered solvent. In most cases, a practically pure condensed solvent is collected and may be used again to thereby reduce material costs. During the process, the sensor 14 monitors evaporation to provide for automated shutoff as disclosed, for example, in US-A- 4,707,452.

Upon completion of an evaporation cycle, the base console 12 facilitates handling of an evaporator assembly 21 during cleaning operations. After detachment of the tubings 111-113 with the threaded couplings 108, the condenser assembly 24 is separated from the evaporation assembly 22 by withdrawing the nose portion 53 of the housing portion 43 from the collar portion 51 of the vessel 40. Next, the dome 70 is separated from the cylindrical body portion 63 of the condenser assembly 24 by withdrawing the condenser nose portion 77 from the condenser collar portion 74. If cleaning of the dome 70 is desired, the fan 80 is removed by withdrawing the stem portion 102 from the O-rings 87 within the cylindrical recess 86 of the drive shaft 85. The dome 70 then can be disengaged from the coupling element 83.

After separation from the evaporation assembly 21, the fluid drive assembly 23 either with or without the dome 70 can be stored conveniently on the support plate 36. The mounting recesses 37 ac-

commodate the motor case 81 while the mounting slots 38 accommodate the middle portion 92 of the coupling element 83. Similarly, after separation from the evaporation vessel 40, the unitary condenser assembly 24 and feed housing 43 can be stored conveniently by inserting the nose portion 53 into one of the retainer recesses 33 on the upper surface 15 of the base 12. Proper care of the system's components is simplified, therefore, by the retainer mechanisms provided with the console base 12.

Claims

1. Apparatus for removing solvent from a solution by evaporating the solvent, said apparatus comprising:

   vessel means (40) defining an opening (52) at the top thereof and forming an evaporation chamber (55) to hold a liquid composition;

   condenser means (24) disposed above and sealed to said vessel means (40) and having wall means (63) defining a condensation chamber (66) in communication with said evaporation chamber (55) through said opening (52), accumulator means (62) for receiving liquid condensed on said wall means (63), and drain means (65) for removing liquid received by said accumulator means;

   fluid drive means (23) disposed above said condenser means for producing fluid flow downwardly through said condensation chamber (66) and into contact with a liquid composition in said evaporation chamber (55) and then upwardly into said condensation chamber (66);

   heating means (13, 25) for heating the liquid composition in said evaporation chamber (55) so as to cause evaporation thereof; and

   cooling means (68) for cooling said wall means (63) so as to produce condensation thereon of vapor included in the fluid flowing upwardly from said evaporation chamber (55).

2. An apparatus according to claim 1, wherein said walls means (63) comprises a substantially vertical condensation tube, said accumulator means (62) comprises an annular trough terminating the bottom of said tube, and said drain means (65) comprises a drain port in a bottom of said trough.

3. An apparatus according to claim 2, wherein said tube and said annular trough are an integrally formed unit.

4. An apparatus according to claim 3, wherein said unit is formed from glass.

5. An apparatus according to claim 2, 3 or 4, wherein said cooling means (68) comprises an annular shroud surrounding said tube and defining a fluid inlet port (71) and a fluid outlet port (72).

6. An apparatus according to claim 5, wherein said tube, said annular trough and said annular shroud are an integrally formed unit.

7. An apparatus according to claim 6, wherein said unit is formed from glass.

8. An apparatus according to any preceding claim, wherein said fluid drive means (23) comprises a fan (80), and an assembly defining a sealed fan chamber (73) retaining said fan and communicating with said condensation chamber (66); said sealed fan chamber (73), said vessel means (40), and said condenser means (24) forming a substantially hermetically sealed closed system providing open fluid communication between said sealed fan chamber, said vessel means and said condenser means.

9. An apparatus according to claim 8, wherein said fan (80) produces said fluid flow in directions radial with respect to said tube.

10. An apparatus according to claim 8 or 9, wherein said assembly comprises a dome shaped enclosure (70) enclosing said fan (80) and having an open bottom end sealed to the upper end of said tube.

11. An apparatus according to any preceding claim, including a closed supply housing means (43) sealed between said condenser means (24) and said vessel means (40); said supply housing means defining a feed port (39) for injecting a solvent into said vessel means.

12. An apparatus according to claim 11, wherein said vessel means (40), said accumulator means (62), and said supply housing means (43) are an integrally formed unit.

13. An apparatus according to claim 12, wherein said unit is formed from glass.

14. An apparatus according to any preceding claim, wherein said vessel means (40) comprises a tubular vessel having an inner wall, and said fluid drive means (23) is adapted to produce said fluid flow in a helical path along said inner wall and into intimate contact with

the liquid composition.

15. An apparatus according to any preceding claim, wherein said heating means comprises base means (12) defining a liquid reservoir (25), heater means (13) for heating a liquid volume retained in said reservoir, and vessel retainer means (31, 32, 33) for retaining said vessel means in a position at least partially submerged in said liquid volume.

16. An apparatus according to claim 15, wherein said condenser means (24) is separable from said vessel means (40) and said fluid drive means (23); and said base means (12) further defines condenser retainer means (33) adapted to retain said condenser means after separation from said vessel means, and fluid drive retainer means (36) adapted to retain said fluid drive means after separation from said condenser means.

Patentansprüche

1. Vorrichtung zum Entfernen eines Lösungsmittels aus einer Lösung durch Verdampfen des Lösungsmittels, wobei diese Vorrichtung umfaßt:
   - eine Aufnahmeeinreichtung (40), die eine Öffnung (52) an ihrer Oberseite ausbildet und eine Verdampfungskammer (55) formt, um eine flüssige Zusammensetzung zu halten,
   - eine Kondensiereinrichtung (24), die oberhalb dieser Aufnahmeeinrichtung (40) angeordnet und mit ihr dichtend verbunden ist und die eine Wandeinrichtung (63) aufweist, die eine Kondensationskammer (66) in Verbindung mit dieser Verdampfungskammer (55) durch diese Öffnung (52) ausbildet, eine Sammeleinrichtung (62) zur Aufnahme von an der Wandeinrichtung (63) kondensierter Flüssigkeit und eine Abführeinrichtung (65) zum Entfernen von durch diese Sammeleinrichtung aufgenommener Flüssigkeit,
   - eine Fluidfördereinrichtung (23), die oberhalb dieser Kondensationseinrichtung angeordnet ist, um einen Fluidstrom nach unten durch diese Kondensationskammer (55) und einen Kontakt mit einer flüssigen Zusammmensetzung in dieser Verdampfungskammer (55) und dann nach oben in diese Kondensationskammer (66) herbeizuführen,
   - eine Heizeinrichtung (13,25) zum Erwärmen der flüssigen Zusammensetzung in dieser Verdampfungskammer (55), um deren Verdampfen zu erreichen, und
   - eine Kühleinrichtung (68) zu Abkühlen dieser Wandeinrichtung (63), um ein Kondensieren des Dampfes, der in dem von der Verdampfungskammern (55) nach oben strömenden Fluid enthalten ist, an dieser Wandeinrichtung herbeizuführen.

2. Vorrichtung nach Anspruch 1, wobei diese Wandeinrichtung (63) einen im wesentlichen vertikal verlaufenden Kondensationstubus umfaßt, diese Sammeleinrichtung eine kreisförmige Rinne umfaßt, die das untere Ende dieses Tubus abschließt, und die Abführeinrichtung (65) eine Ablaßeinrichtung am Boden dieser Rinne umfaßt.

3. Vorrichtung nach Anspruch 2, wobei dieser Tubus und diese kreisförmige Rinne eine materialeinstückig hergestellte Einheit sind.

4. Vorrichtung nach Anspruch 3, wobei diese Einheit aus Glas hergestellt ist.

5. Vorrichtung nach einem der Ansprüche 2 - 4, wobei diese Kühleinrichtung (68) eine zylinderförmige Ummantelung umfaßt, die diesen Tubus umgibt und eine Fluideintrittsöffnung (71) und eine Fluidaustrittsöffnung (72) festlegt.

6. Vorrichtung nach Anspruch 5, wobei dieser Tubus, diese kreisförmige Rinne und diese zylinderförmige Ummantelung eine materialeinstückig hergestellte Einheit sind.

7. Vorrichtung nach Anspruch 6, wobei diese Einheit aus Glas hergestellt ist.

8. Vorrichtung nach einem der Ansprüche 1 - 7, wobei diese Fluidfördereinrichtung (23) einen Rotor (80) und eine Einheit aufweist, die eine abgedichtete Rotorkammer (73) ausbildet, die diesen Rotor aufnimmt und in Verbindung mit dieser Kondensationskammer (66) steht, und wobei diese abgedichtete Rotorkammmer (73), diese Aufnahmeeinrichtung (40) und diese Kondensationseinrichtung (24) ein im wesentlichen hermetisch abgedichtetes geschlossenes System bilden und eine freie Fluidzirkulation zwischen dieser abgedichtete Rotorkammmer, dieser Aufnahmeeinrichtung und dieser Kondenastionseinrichtung herbeiführen.

9. Vorrichtung nach Anspruch 8, wobei dieser Rotor (80) einen Fluidstrom in radialer Richtung bezüglich des Tubus herbeiführt.

10. Vorrichtung nach Anspruch 8 oder 9, wobei diese Einheit eine kuppelförmige Umhüllung (70) aufweist, die den Rotor (80) umgibt, und ein offenes Bodenende aufweist, das dichtend am oberen Ende dieses Tubus befestigt ist.

11. Vorrichtung nach einem der Ansprüche 1 - 10, die eine geschlossene Zuführumhülleinrichtung (43) aufweist, die zwischen dieser Kondensiereinrichtung (24) und dieser Aufnahmeeinrichtung (40) dichtend angebracht ist, wobei diese Zuführumhülleinrichtung eine Zuführöffnung (30) zum Einbringen eines Lösungsmittels in diese Aufnahmeeinrichtung aufweist.

12. Vorrichtung nach Anspruch 11, wobei diese Aufnahmeeinrichtung (40), diese Sammeleinrichtung (62) und diese Zuführumhülleinrichtung (43) eine materialeinstückig hergestellte Einheit sind.

13. Vorrichtung nach Anspruch 12, wobei diese Einheit aus Glas hergestellt ist.

14. Vorrichtung nach einem der Ansprüche 1 - 13, wobei diese Aufnahmeeinrichtung (40) einen tubusförmigen Kolben mit einer inneren Wand aufweist, und diese Fluidfördereinrichtung (23) fähig ist, diesen Fluidstrom längs einer helixförmigen Linie entlang dieser inneren Wand und in engem Kontakt mit dieser flüssigen Zusammensetzung herbeizuführen.

15. Vorrichtung nach einem der Ansprüche 1 - 14, wobei diese Heizeinrichtung eine Basiseinrichtung (12) aufweist, die ein Flüssigkeitsreservoir definiert, Heizer (13) zum Erwärmen eines flüssigen, in diesem Reservoir aufgenommenen Volumens und Aufnahmeeinrichtungshaltemittel (31,32,33) zum Festhalten dieser Aufnahmeeinrichtung in einer wenigstens teilweise in dieses flüssige Volumen eingetauchten Stellung.

16. Vorrichtung nach Anspruch 15, wobei diese Kondensationseinrichtung (24) von der Aufnahmeeinrichtung (40) und der Fluifördereinrichtung (23) trennbar ist, und diese Basiseinrichtung (12) darüber hinaus Kondensationseinrichtungsrückhaltemittel (33) aufweist, die diese Kondensationseinrichtung nach der Trennung von dieser Aufnahmeeinrichtung zurückhalten können, und Fluidfördereinrichtungsrückhaltemittel (36), die diese Fluidfördereinrichtung nach dem Trennen von dieser Kondensationseinrichtung zurückhalten können.

R vendications

1. Dispositif pour enlever un solvant d'une solution en faisant évaporer le solvant, ledit dispositif comprenant :

   un moyen de récipient (40) définissant une ouverture (52) à son sommet et formant une chambre d'évaporation (55) pour contenir une composition liquide,

   un moyen de condenseur (24) disposé au-dessus et scellé audit moyen de récipient (41) ayant un moyen de paroi (63) définissant une chambre de condensation (66) en communication avec ladite chambre d'évaporation (55) par l'intermédiaire de ladite ouverture (52), un moyen d'accumulateur (62) pour recevoir le liquide condensé sur ledit moyen de paroi (63) et un moyen d'évacuation (65) pour enlever le liquide reçu par ledit moyen d'accumulateur,

   un moyen d'entraînement de fluide (23) disposé au-dessus dudit moyen de condenseur afin de produire un écoulement du fluide vers le bas à travers ladite chambre de condensation (66) et en contact avec une composition liquide dans ladite chambre d'évaporation (55) et ensuite vers le haut dans ladite chambre de condensation (66),

   un moyen de chauffage (13, 25) pour chauffer la composition liquide dans ladite chambre d'évaporation (55) de façon à entraîner son évaporation, et

   un moyen de refroidissement (68) pour refroidir ledit moyen de paroi (63) de façon à produire une condensation sur celle-ci de vapeur incluse dans le fluide s'écoulant vers le haut à partir de la chambre d'évaporation (55).

2. Dispositif selon la revendication 1, dans lequel ledit moyen de paroi (63) comprend un tube de condensation pratiquement vertical, ledit moyen d'accumulateur (62) comprend une cuve annulaire terminant le fond dudit tube et ledit moyen d'évacuation (65) comprend un orifice d'évacuation dans le fond de ladite cuve.

3. Dispositif selon la revendication 2, dans lequel ledit tube et ladite cuve annulaire constituent une unité formée solidairement.

4. Dispositif selon la revendication 3, dans lequel ladite unité est constituée de verre.

5. Dispositif selon la revendication 2, 3 ou 4, dans lequel ledit moyen de refroidissement 68 comprend une enveloppe annulaire entourant ledit tube et définissant un orifice d'entrée de fluide (71) et un orifice de sortie de fluide (72).

6. Dispositif selon la revendication 5, dans lequel ledit tube, ladite cuve annulaire et ladite enveloppe annulaire constituent une unité formée solidairement.

7. Dispositif selon la revendication 6, dans lequel ladite unité est constituée de verre.

8. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit moyen d'entraînement du fluide (23) comprend un ventilateur (80) et un ensemble définissant une chambre de ventilateur fermée (73) retenant ledit ventilateur et communicant avec ladite chambre de condensation (66), ladite chambre de ventilateur fermée (73), ledit moyen de récipient (40) et ledit moyen de condenseur (24) formant un système fermé scellé pratiquement hermétiquement procurant une communication fluidique ouverte entre ladite chambre de ventilateur fermée, ledit moyen de récipient et ledit moyen de condenseur.

9. Dispositif selon la revendication 8, dans lequel ledit ventilateur 80 produit ledit écoulement du fluide dans des directions radiales par rapport audit tube.

10. Dispositif selon la revendication 8 ou 9, dans lequel ledit ensemble comprend une enceinte en forme de dôme (70) enfermant ledit ventilateur (80) et ayant une extrémité inférieure ouverte scellée à l'extrémité supérieure dudit tube.

11. Dispositif selon l'une quelconque des revendications précédentes, comportant un moyen de logement d'alimentation fermé (43) scellé entre ledit moyen de condenseur (24) et ledit moyen de récipient (40), ledit moyen de logement d'alimentation définissant un orifice d'alimentation (39) pour injecter un solvant dans ledit moyen de récipient.

12. Dispositif selon la revendication 11, dans lequel ledit moyen de récipient (40), ledit moyen d'accumulateur (62) et ledit moyen de logement d'alimentation (43) constituent une unité formée solidairement.

13. Dispositif selon la revendication 12, dans lequel ladite unité est constituée de verre.

14. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de récipient (40) comprend un récipient tubulaire ayant une paroi interne et ledit moyen d'entraînement de fluide (23) est prévu pour produire ledit écoulement du fluide en un trajet hélicoïdal suivant ladite paroi interne et en contact intime avec la composition liquide.

15. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de chauffage comprend un moyen d'embase (12) définissant un réservoir de liquide (25), un moyen chauffant (13) pour chauffer un volume liquide retenu dans ledit réservoir et un moyen de maintient de récipient (31, 32, 33) pour maintenir ledit moyen de récipient en une position au moins partiellement immergée dans ledit volume liquide.

16. Dispositif selon la revendication 15, dans lequel ledit moyen de condenseur (24) est séparable dudit moyen de récipient (40) et dudit moyen d'entraînement de fluide (23) et ledit moyen d'embase (12) définit de plus un moyen de maintient de condenseur (33) prévu pour maintenir ledit moyen de condenseur après séparation dudit moyen de récipient et un moyen de maintient d'entraînement de fluide (36) prévu pour maintenir ledit moyen d'entraînement de fluide après séparation dudit moyen de condenseur.

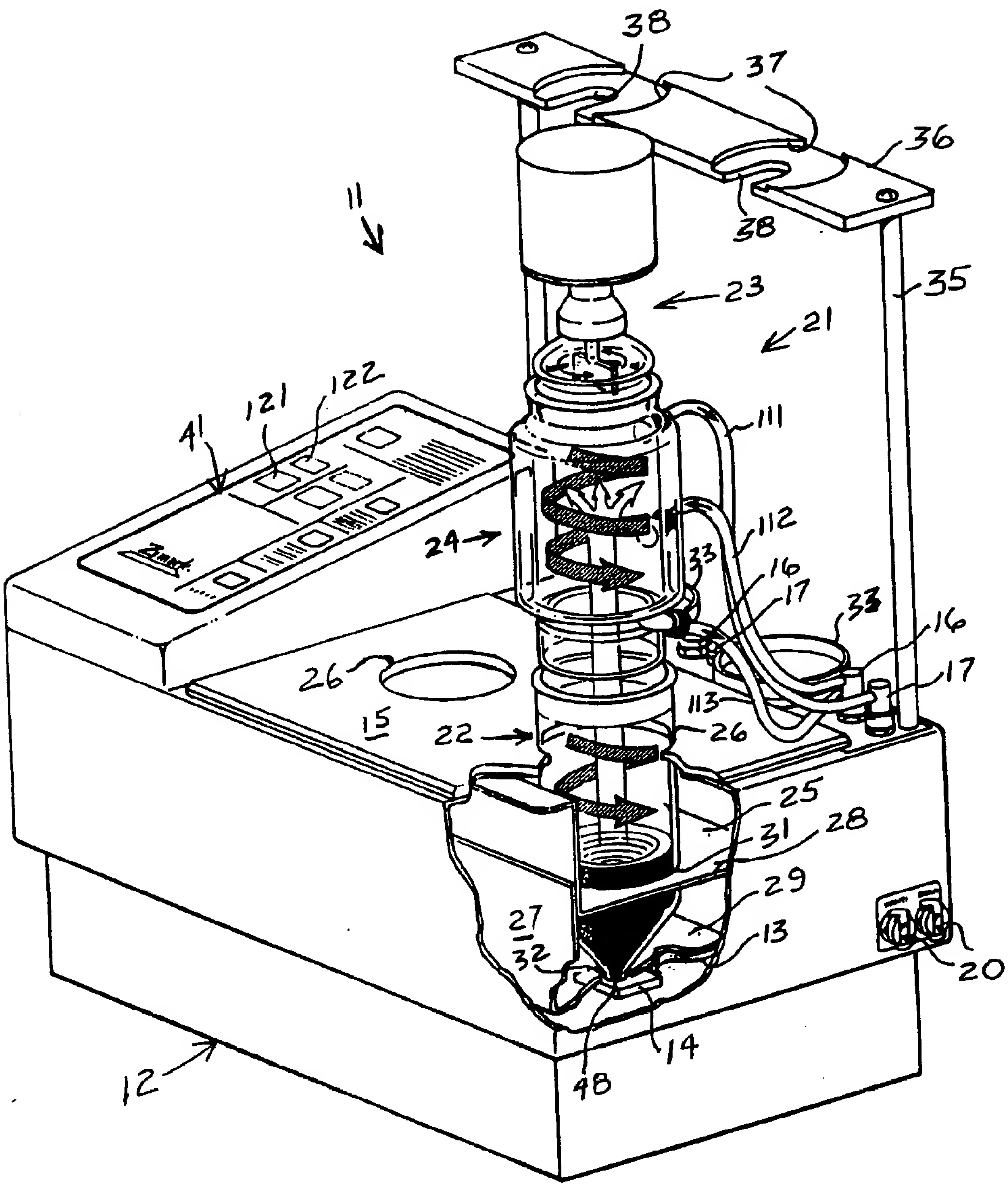
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FIG. 1

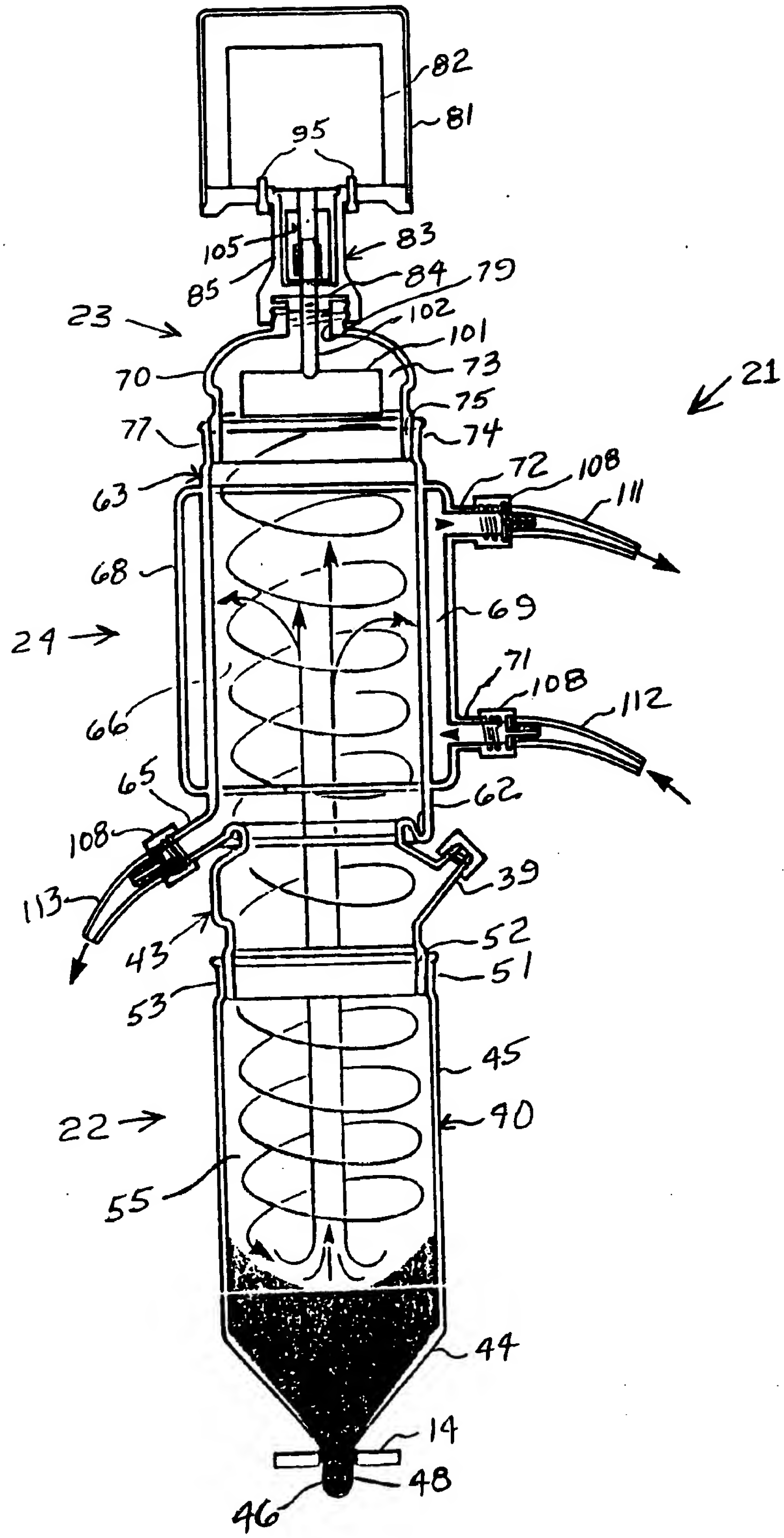
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FIG.2

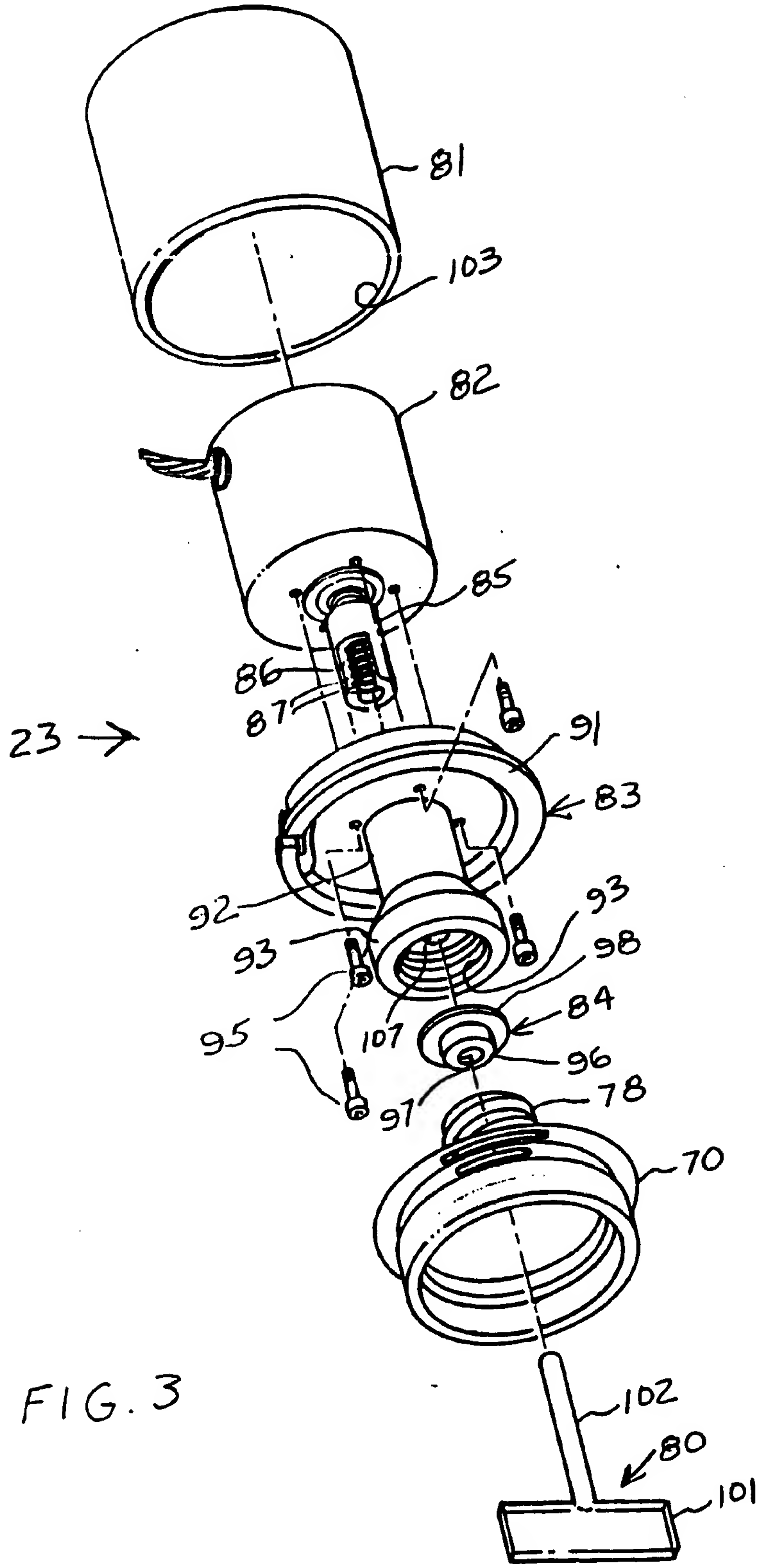
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FIG. 3